

DESCRIPTION

METHOD OF FORMING BY FORGING AND A CASE FORMING METHOD

TECHNICAL FIELD

The present invention relates to a method of forming by forging and a case forming method.

BACKGROUND ART

Various types of machine parts and the like are often manufactured by forging for cost reasons. In such cases, it often happens that the intermediate product requires the formation of an overlay on the plate core material. This is the case in, for example, the manufacture of parts such as sprockets, gears, pulleys, cams, links and fixing brackets.

Also, cup-shaped cases with a boss provided on the inside are widely employed in various fields. For example, the case of the electromagnetically controlled valve of an injection apparatus used to supply fuel to the cylinders in an internal combustion engine is a cup-shaped member with an integrally formed inside boss for affixing the electromagnetic coil and the magnetic core. Cup-shaped cases such as these having an inside boss are also usually formed by forging, for cost reasons, and in the intermediate product form require the formation of overlays on the plate core material.

In the prior art the method of fabrication used in cases such as these in which material is to be shaped by forging and the intermediate product requires the formation of an overlay on plate core material, has

been to press-form cylindrical material obtained by cutting low-carbon round steel bar.

Japanese Unexamined Patent Application publication No. 2000-94088 discloses a method of forming a cup with an inside boss in which the material is obtained by spheroidizing annealing a forged slab and subjecting the material to shot bonderizing treatment. Because the method includes the step of cutting round steel bar, it endeavors to reduce the cutting cost by using round bar having a relatively small diameter, and gives the material a thick configuration suitable for forming a cup having an internal boss by forging the cut sections of round bar. To eliminate such tasks, there is also known a method of forming a case having an internal boss by preparing and forging a flat steel slab.

However, in the case of the above method in which the intermediate product is formed by stamping cylindrical material obtained by cutting low-carbon round steel bar, there are problems such as a high cutting cost, making the end product costly.

Also, when a cup-shaped case is formed with an internal boss by the forging of sheet material, the cup is stamping-formed by the forward drawing of relatively thin sheet material, so there tends to be a lack of bulk which can make it difficult to ensure that the bottom is thick enough to form the internal boss by forming the bottom of the cup thicker than the peripheral wall.

An object of the invention is to provide a method of forming by forging and a case forming method capable of overcoming the aforesaid problems of the prior art.

An object of the invention is to provide a method of forming for manufacturing a high-quality case by blanking of sheet material.

Another object of the invention is to provide a case forming method capable of manufacturing high-quality cases at low cost.

DISCLOSURE OF THE INVENTION

A characterizing feature of the invention is that the method of forming by forging material comprises a first step of preparing sheet material, and a second step in which a thickness of a circumferential portion of the material is made thinner than a thickness of a center portion of the material.

Another characterizing feature of the invention is that the case forming method comprises a first step of preparing the sheet material, and a second step in which a thickness of a circumferential portion of the material is formed to be thinner than a thickness of a center portion of the material.

Another characterizing feature of the invention is that the method of forming a cup-shaped case having an internal boss comprises a step of preparing sheet material, a step of forming a circumferential portion of the material to be thinner than a thickness of a center portion of the material while simultaneously time stamping-forming the thicker center portion into a concave shape, and a step of using forward drawing to stamping-form the intermediate product formed by the above stamping-forming into a cup-shaped member having a bottom that is thicker than the peripheral wall.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a diagram for illustrating the process of forming a case with an internal boss in accordance with the invention.

Figure 2 is a diagram for illustrating the process of forming a case with an internal boss in accordance with the invention.

Figure 3 is a diagram for illustrating the process of forming a case with an internal boss in accordance with the invention.

Figure 4 is a diagram for illustrating the process of forming a case with an internal boss in accordance with the invention.

Figure 5 is a diagram for illustrating the process of forming a case with an internal boss in accordance with the invention.

Figure 6 is a diagram illustrating the forming process when the first intermediate formed product shown in Figure 2 is used to manufacture a gear.

Figure 7 is a diagram illustrating the forming process when the first intermediate formed product shown in Figure 2 is used to manufacture a gear.

Figure 8 is a diagram illustrating the forming process when the first intermediate formed product shown in Figure 2 is used to manufacture a gear.

Figure 9 is a diagram illustrating the forming process when the first intermediate formed product shown in Figure 2 is used to manufacture a pulley.

Figure 10 is a diagram illustrating the forming process when the first intermediate formed product shown in Figure 2 is used to manufacture a pulley.

Figure 11 is a diagram illustrating the forming process when the first intermediate formed product shown in Figure 2 is used to manufacture a pulley.

BEST MODE OF CARRYING OUT THE INVENTION

Embodiments of the invention will now be explained in detail with reference to the drawings.

Figures 1 to 5 are process ironings for explaining an embodiment of method of the invention, applied to the manufacture of the case of an electromagnetically controlled valve of a fuel injection apparatus used to supply fuel to an internal combustion engine.

First, the sheet member shown in Figure 1 is prepared as material 1. The material 1 can be obtained by, for example, by blanking and stamping low-carbon steel sheet. Here, material 1 is a disk-shaped member, but it does not have to be disk-shaped.

Next, upsetting is used to reduce the thickness of the periphery compared to the thickness at the center portion while forming a concavity in the thick center portion, forming the first intermediate formed product 2 shaped as shown in Figure 2. The intermediate formed product 2 shown in Figure 2 has a circumferential thin annular portion 21, a thick portion 22 on the inside of the thin annular portion 21 that is thicker than the thin annular portion 21, and a concave portion 22A on the center portion of the thick portion 22.

In subsequent process steps, the thick portion 22 is formed into at least the case bottom and internal boss, so it is thickened to allow for at least the amount of material for the internal boss formed integrally with the bottom. Before being processed in the next step, it is preferable for the first intermediate formed product 2 to be annealed to prevent cracking occurring in the subsequent process steps.

In the following drawing and ironing step, the first intermediate formed product 2 is stamping-formed to form the thick

portion 22 into a bottom 32 and the thin annular portion 21 into a peripheral wall 31 that extends integrally from the bottom 32, thereby forming a second intermediate formed product 3 shaped as shown in Figure 3. Since the first intermediate formed product 2 has the concave portion 22A in the center thereof, the second intermediate formed product 3 of Figure 3 can readily be obtained by the drawing and ironing process. In order to form an external flange around the edge of the peripheral wall of the case, drawing and ironing are used to slightly thicken the outer edge 31A of the peripheral wall 31, giving the wall 31 a skirt-like shape. The thickness of the peripheral wall 31 is less than the thickness of the bottom 32. If an external flange is not needed, it is not necessary to thicken the outer edge 31A.

In the next forward/backward drawing to which the second intermediate formed product 3 is subjected to form it into the third intermediate formed product 4 shown in Figure 4, internal boss 43 is formed on the inside of the bottom 42, external boss 44 is formed on the outside of the bottom 42, and external flange 41A is formed on the edge of the peripheral wall 41. Only forward drawing is required in cases in which the external boss 44 is not needed.

In the next step, two dies are used to stamp the third intermediate formed product 4 into the intended final shape to obtain, as the final product, the case 5 having an internal boss shown in Figure 5. In the case 5 thus formed, the bottom 52 and peripheral wall 51 are approximately the same thickness and the internal boss 53 and external boss 54 on the bottom 52 are coaxial. The internal boss 53 is provided in order to incorporate an electromagnetic solenoid, and the external boss 54 is provided to accommodate a bearing. An external flange 51A on the

outside edge of the peripheral wall 51 extends integrally at a right-angle to the peripheral wall 51.

When a case with an internal boss is formed in accordance with the steps of Figures 1 to 5, since it is possible to draw sheet material to form an internal boss and/or an external boss in the bottom, it is possible to readily manufacture a high-quality product at a lower cost compared to the prior art in which a case is formed with an internal boss from a cut section of round bar. Moreover, in a modified version of the example shown in Figure 5, it is also possible to form just an internal boss. In particular, using the same volume to form just an internal boss makes it possible to form an internal boss that is higher than when both internal and external bosses are formed.

While the above explanation has been made with reference to one embodiment of the invention, the first intermediate formed product 2 shown in Figure 2 is a general-purpose member. The first intermediate formed product 2 can be used as an intermediate product in the manufacturing of, for example, sprockets, gears, pulleys, cams, links and fixing brackets.

The steps of using the first intermediate formed product 2 of Figure 2 to manufacture a gear will now be described with reference to Figures 6 to 8. First, the first intermediate formed product 2 is prepared and subjected to forward/backward drawing forging steps whereby the thick center portion of the first intermediate formed product 2 is formed into a boss 61 and the thin portion is formed into a thin annular portion 62 having a uniform thickness. Here, the boss 61 is cup-shaped, formed as a cylinder with a bottom.

The intermediate formed product in Figure 6 is stamped to remove the bottom 61A of the boss 61, forming the cylindrical boss 63 shown in Figure 7.

Then, the periphery of the thin annular portion 62 is trimmed and blanked, forming a plurality of teeth 62A to thereby obtain a gear 6 having a boss 63 (Figure 8).

The steps of using the first intermediate formed product 2 of Figure 2 to manufacture a pulley will now be described with reference to Figures 9 to 11. First, the first intermediate formed product 2 is prepared and stamped to increase the thickness of the peripheral edge of the thin portion, thereby forming the outer ring 71 shown in Figure 9.

After forming the outer ring 71, forward/backward drawing forging steps are used whereby the thick center portion is formed into a boss 72 and a thin annular portion 73 having a uniform thickness is formed between the outer ring 71 and the boss 72 (Figure 10). Here, the boss 72 is cup-shaped, formed as a cylinder with a bottom, and the outer ring 71 is formed to have the required dimensions for outer ring 74.

Then, the bottom 72A of the boss 72 is punched to remove it, forming the cylindrical boss 75 shown in Figure 11.

In accordance with the above steps, a pulley 7 is obtained comprising the boss 75 and the outer ring 74 integrated by the thin annular portion 73 of uniform thickness. For end product application, a groove may be formed on the outer ring 74 by machining or the like.

INDUSTRIAL APPLICABILITY

The method of forming by forging and a case forming method according to the invention, as described in the foregoing, is useful for the

low-cost fabrication of parts such as sprockets, gears, pulleys, cams and fixing brackets, and for the low-cost, high-quality manufacture of cup-shaped cases with an internal boss.